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(54) **SYSTEM AND METHOD FOR DYNAMICALLY DETERMINING THE ATTITUDE OF AN AUTHOR OF A NATURAL LANGUAGE DOCUMENT**

(75) Inventors: **Livia Polanyi**, Palo Alto, CA (US); **Annie Zaenen**, Redwood City, CA (US)

(73) Assignee: **Fuji Xerox Co., Ltd.**, Tokyo (JP)

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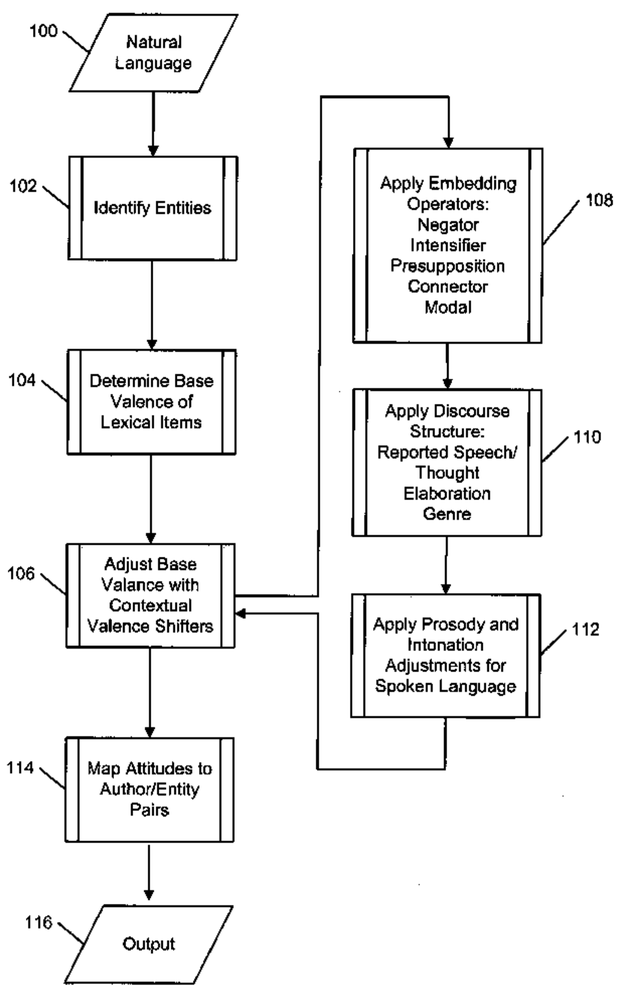
Primary Examiner—Richemond Dorvil
Assistant Examiner—Leonard Saint-Cyr
(74) *Attorney, Agent, or Firm*—Fliesler Meyer LLP

(57) **ABSTRACT**

A method for adaptively analyzing a natural language document containing at least one lexical item, said analysis to determine an attitude of an author towards an entity, comprising determining at least one actual valence for the at least one lexical item by analyzing the at least one lexical item in context, determining the attitude based on the at least one actual valence, associating the author, the entity and the attitude, and wherein the at least one lexical item encodes attitude information about the entity.

62 Claims, 2 Drawing Sheets



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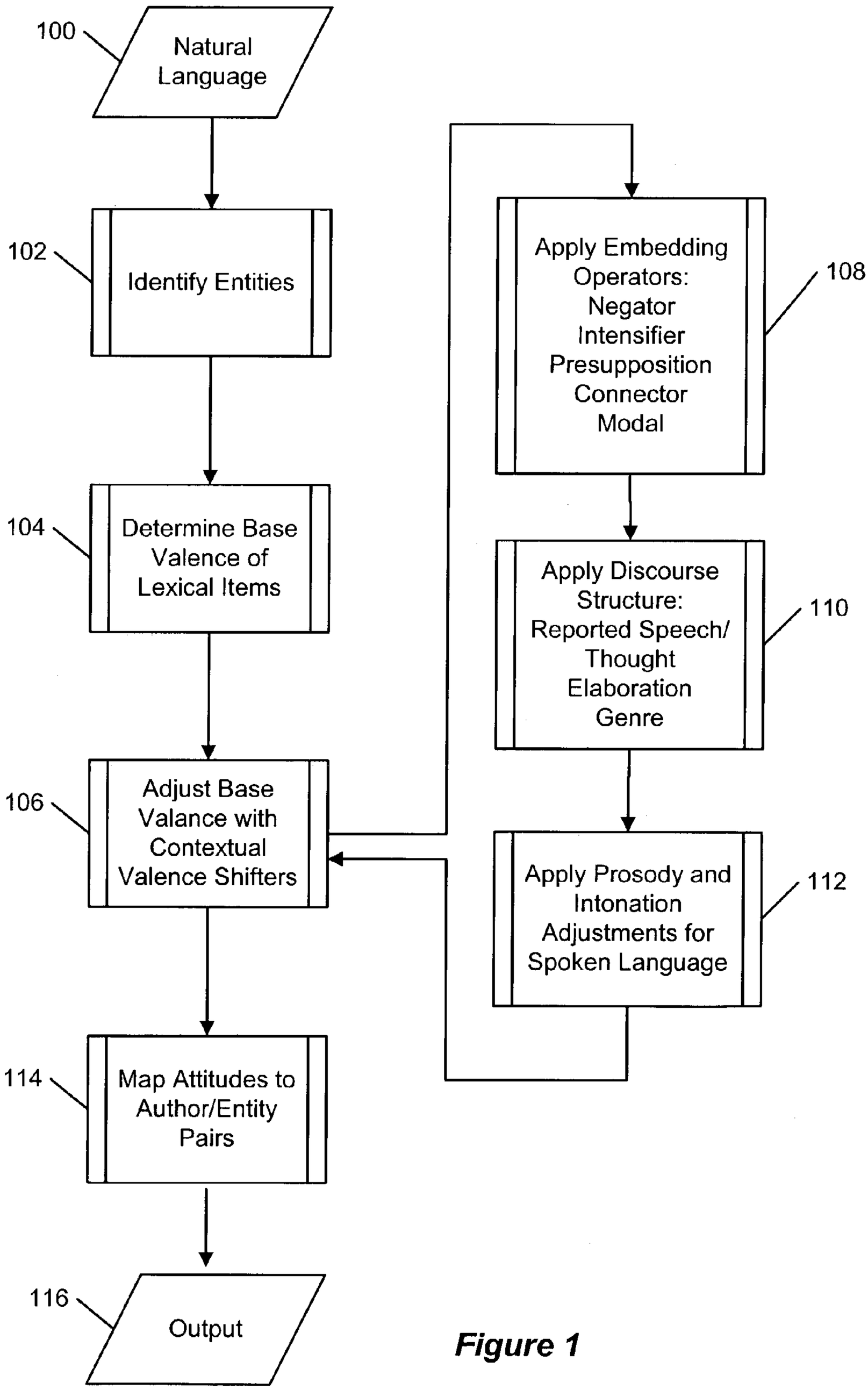
100
Natural Language
102
Identify Entities
104
Determine Base Valence of Lexical Items
106
Adjust Base Valance with Contextual Valence Shifters
108
Apply Embedding Operators: Negator Intensifier Presupposition Connector Modal
110
Apply Discourse Structure: Reported Speech/ Thought Elaboration Genre
112
Apply Prosody and Intonation Adjustments for Spoken Language
114
Map Attitudes to Author/Entity Pairs
116
Output

Figure 1

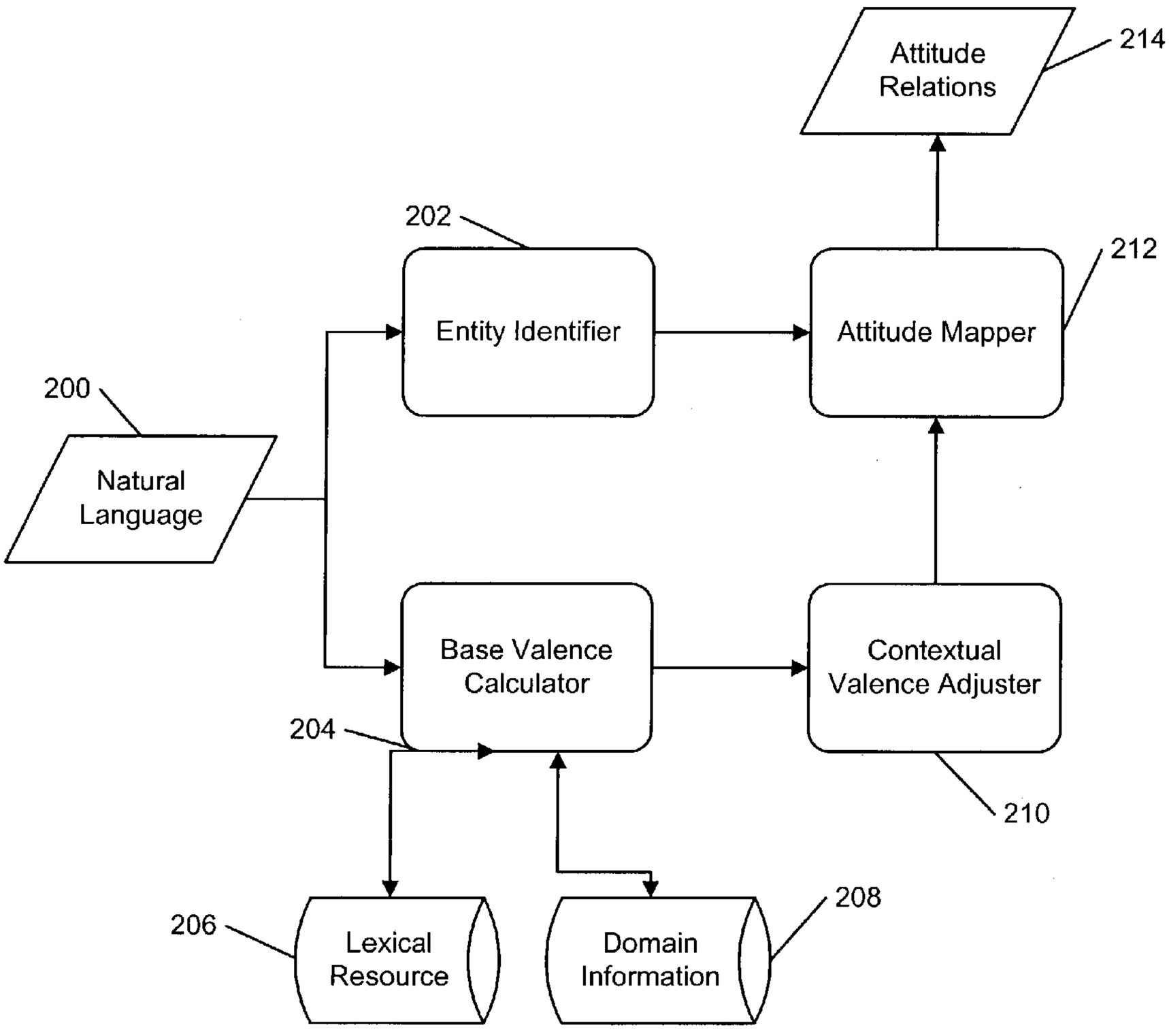
Attitude Relations
214
202
Entity Identifier
Attitude Mapper
212
200
Natural Language
Base Valence Calculator
Contextual Valence Adjuster
204
210
206
Lexical Resource
Domain Information
208

Figure 2

SYSTEM AND METHOD FOR DYNAMICALLY DETERMINING THE ATTITUDE OF AN AUTHOR OF A NATURAL LANGUAGE DOCUMENT

CROSS REFERENCES

This application is related to the following co-pending applications which are each hereby incorporated by reference in their entirety: SYSTEM AND METHOD FOR SUMMARIZATION COMBINING NATURAL LANGUAGE GENERATION WITH STRUCTURAL ANALYSIS, U.S. application Ser. No. 10/231,732; Inventors: Livia Polanyi, et al., filed on Aug. 30, 2002; SYSTEM AND METHOD FOR DYNAMICALLY DETERMINING THE FUNCTION OF A LEXICAL ITEM BASED ON CONTEXT, U.S. application Ser. No. 10/364,038, Inventors: Livia Polanyi, et al., filed on Feb. 11, 2003; SYSTEM AND METHOD FOR DYNAMICALLY DETERMINING THE FUNCTION OF A LEXICAL ITEM BASED ON DISCOURSE HIERARCHY STRUCTURE, U.S. application Ser. No. 10/364,191, Inventors: Livia Polanyi, et al., filed on Feb. 11, 2003; and SYSTEMS AND METHODS FOR DYNAMICALLY DETERMINING THE ATTITUDE OF A NATURAL LANGUAGE SPEAKER, U.S. application Ser. No. 10/387,719, Inventors: Livia Polanyi, et al., filed on Mar. 13, 2003.

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FIELD OF THE DISCLOSURE

The present invention disclosure relates to automatic analysis of natural language, and in particular, the dynamic determination of an author's attitudes towards entities and events discussed in the author's writing.

BACKGROUND

It is sometimes desirable to ascertain the attitude of an author of document towards entities or events described therein. For example, in the customer relations context it is important to ascertain whether the author of an electronic mail message has a positive or negative attitude towards a company's products and services. Some methods of attitude evaluation involve merely summing the number of terms in a document having positive versus negative connotations to derive a score for the document as a whole. For example, positive words can be assigned a positive value while negative words are assigned a negative value. In this approach, the sum of the values would represent the (positive or negative) attitude of the author. This approach is too simplistic, however, since it does not discriminate between entities or events discussed in the document, some of which the author may view in a positive light and others the author may view negatively. Another limitation of this approach is that it fails to take into account the influence that context can have on nominally positive or negative terms.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a flow chart illustrating one embodiment of the invention.

FIG. **2** is diagram of a system in accordance to one embodiment of the invention.

DETAILED DESCRIPTION

The invention is illustrated by way of example and not by way of limitation in the figures of the accompanying drawings in which like references indicate similar elements. It should be noted that references to "an" or "one" embodiment in this disclosure are not necessarily to the same embodiment, and such references mean at least one.

Lexical items (e.g., words or phrases) encode a mixture of positive and negative information from which authors' attitudes or opinions regarding entities and events can be inferred. This encoded information is referred to as valence or connotation. For example, the words heroic and tragic used to describe the same event have entirely different connotations. Assuming that an author chooses words that aptly express the author's meaning, an event described as heroic is expressing the author's positive attitude towards the event. Whereas an author who refers to an event as tragic is taking the opposite stand.

Lexical items can also be used by an author to indirectly express an attitude. For example:

(1) John is inconsiderate.

(2) John arrived early. That was inconsiderate.

The sentence in text (1) above has a lexical item "inconsiderate" that carries with it a negative connotation reflecting the author's unenthusiastic assessment of the entity "John". However, in text (2) the same is accomplished indirectly. The first sentence in (2) has a lexical item "arrived early" that has either a neutral or positive connotation (as compared to "arrived late") reflecting the author's attitude towards the entity "John". But the second sentence in (2) contains the lexical item "inconsiderate" which refers to the act of John arriving early and indirectly implicates John. From this it can be inferred that the author is also expressing a negative assessment of John.

A natural language can be a language that humans use to communicate with each other, such as English, Japanese, French, Spanish, etc. This invention disclosure is not limited to or dependent on any particular natural language. A natural language document (hereinafter referred to as a "document") includes natural language communication and can be of any length. By way of a non-limiting example, a document can take many forms including but not limited to discourse (e.g., speech or conversation in spoken or written form), printed materials (e.g., newspaper, magazine articles, books, etc.), digital information (e.g., electronic mail messages, web pages, documents in electronic form, etc.), and interactive electronic forums (e.g., instant messaging, "chat" rooms, bulletin boards, etc.).

Generally speaking, entities discussed or alluded to in natural language documents can be persons, places, things, ideas, concepts, etc. Identification of entities or events in a document can be accomplished a number of ways, including using information extraction (IE) techniques. IE systems usually take as input a query that describes the information sought after and a template that specifies how the results of the query should be formatted. Two possible approaches to IE are knowledge engineering and automatic training. The knowledge engineering approach uses hand-crafted extrac-

tion rules based on domain patterns discovered by a human expert through analysis of a corpus. Automatic training systems learn extraction rules by analyzing texts that have been annotated (by a human expert) to point out which information is important. For purposes of this invention disclosure, the particular IE technique or system employed—whether currently existing or yet to be discovered—is immaterial.

IE systems can be "coarse-grained" or "fine-grained". At the "coarsest" level of entity extraction, there is the document itself. At a deeper or less coarse level, we have general topic or subject areas in the document. Deeper still, particular entities/events are identified. And so on. A coarse-grained system operates quickly but shallowly, allowing for fast operation but limited entity extraction. Fine-grained systems occupy the opposite end of the spectrum and can extract far more entities but at a slower speed. Of course, the type of extraction desired (i.e., shallow/coarse or deep/fine) can be tailored to the particular application area based on speed and depth requirements. In any case, a natural byproduct of IE is that the entities and events so extracted can be associated with the lexical items that directly or indirectly refer to them.

Generally speaking, lexical items can have a base valence or connotation that is positive, negative or neutral. In one embodiment, a lexical item's base valence could be stored in an electronic dictionary or lexical resource. In one embodiment, a negative or positive number can be associated with a lexical item to reflect its valence. By way of a non-limiting illustration, Table 1 lists English verbs, adjectives (and adverbs) and nouns which can be characterized as positively or negatively valenced.

TABLE 1

Base Valence of Exemplary Lexical Items

PART OF SPEECH	POSITIVE	NEGATIVE
Verb	Boost, Ease, Embrace Encourage, Ensure, Manage, Delight, Reassure	Conspire, Discourage, Fail, Fiddle, Haggle, Meddle
Noun	Approval, Benefit Chance, Credit, Favor, Freedom, Hope, Incentive, Innovation, Justification, Promise, Reliability, Solution, Success	Backlash, Backlog, Bankruptcy, Beating, Catastrophe, Complacency, Destruction, Egotism, Failure, Frown, Grimace, Guilt, Jealous, Lie, Mortuary, Theft, Vanity
Adjective	Attractive, Better, Brave, Bright, Creative, Dynamic, Generous, Improving, Innovative, Reliable, Secure, Successful	Annoying, Arbitrary, Awry, Bad, Botched, Capricious, Counterproductive, Disappointing, Dreadful, Flawed, Guilty, Half Baked
Adverb	Attractively	Annoyingly

Sometimes it is difficult to determine the base valence of a lexical item without considering the context in which it occurs. For example, the lexical item bankruptcy when applied to a financial event can be an objective description and not an evaluation. Given that the event itself is generally perceived as negative, the word tends to be used in a broader context as a negative term. For this reason, in one embodiment context or domain information could be included in an electronic dictionary or lexical resource to aid in the appropriate selection of the base valence of a lexical item based on how the lexical item is used in a document.

By way of a further non-limiting illustration, the following texts (3)-(5) all communicate the same set of facts but the connotative force of the three texts is quite different.

(3) The eighteen year old walked through the part of town where he lived. He stopped for a while to talk with people on the street and then went to a store for some food to bring to the small apartment where he lived with some people he knew.

(4) The young man strolled through the neighborhood where he lived. He lingered to chat with people on the street and then dropped into a shop for some goodies to bring home to the cozy place which he shared with some friends.

(5) The teenaged male strutted through his turf. He loitered to shoot the bull with people on the street and then ducked into a dive for some grub to bring to the cramped hole-in-the-wall where he crashed with his some cronies.

Text (3) above is a neutral text that presents the facts without much attitudinal assessment of them. The facts in Text (4) are essentially identical: no new factual information about the eighteen year old from (3) has been added. Yet the young man in (4) emerges as a sympathetic character due to the presence of lexical items such as "strolled", "chat", "cozy" and "friends". In Text (5) the pleasant young man of (4) has changed into a juvenile delinquent. The only differences between (3)-(5) lies in the exact choice between valenced synonyms or near synonyms selected to describe the protagonist and his environs. These are summarized in Table 2.

TABLE 2

Valence of Synonyms

TEXT (3): NEUTRAL VALENCE	TEXT (4): POSITIVE VALENCE	TEXT (5): NEGATIVE VALENCE
Eighteen year old	Young man	Teenaged male
walked	Strolled	strutted
part of town	Neighborhood	turf
stopped	Lingered	loitered
talk	Chat	shoot the bull
store	Shop	dive
food	Groceries	grub
Small	Cozy	cramped
apartment	Place	hole in the wall
lived	Shared	crashed
people	Friends	cronies

The actual valence of a lexical item in use in a particular context in a particular document is not necessarily identical with the base valence of the lexical item in a lexicon. To take a simple example, the sentence "John is not brilliant." The lexical item "brilliant" has a positive base valence, but the sentence does not express a positive evaluation of John's mental prowess. On the contrary, the negative term "not" when applied to "brilliant" effectively counteracts or shifts the valence of "brilliant" from positive to negative. Therefore, the base valence can change to reflect the context in 5 which the lexical item occurs. Words, phrases or document properties that affect the valence of lexical items are referred to as contextual valence shifters (CVS's). A CVS can affect the base valence of lexical items in its scope. For example, the CVS "not" in "John is not brilliant" has lexical item scope—it only modifies the lexical item that follows it.

In one embodiment, a negator is a CVS that can invert the base valence of a lexical item. By way of a non-limiting example, negators can belong to various word classes (e.g., never, none, nobody, nowhere, nothing, neither, etc.). The combination of a positively valenced lexical item with a

negator turns the evaluation as a whole into a negative one; inversely the combination of a negator with a negatively valenced lexical item turns the whole into a positive evaluation.

TABLE 3

Negator and Intensifier Examples

	DOCUMENT	ATTITUDE
(6)	John is *clever*$^{+1}$.	*A* $\xrightarrow{+1}$ *John*
(7)	John is **not** *clever*$^{+1}$.	*A* $\xrightarrow{-1}$ *John*
(8)	Each of them is *successful*$^{+1}$.	*A* $\xrightarrow{+1}$ *Them*
(9)	**None** of them is *successful*$^{+1}$.	A $\xrightarrow{-1}$ Them
(10)	John **seldom** is *successful*$^{+1}$ at tennis.	*A* $\xrightarrow{0}$ *John + Tennis*
(11)	John is **always** *successful*$^{+1}$ at tennis	*A* $\xrightarrow{+2}$ *John + Tennis*
(12)	John is **less** *successful*$^{+1}$ at tennis.	*A* $\xrightarrow{+0.5}$ *John + Tennis*

By way of a non-limiting illustration, Table 3 depicts documents in the "DOCUMENT" column and corresponding attitude expressions in the "ATTITUDE" column. The base valence of lexical items in the DOCUMENT column is indicated with a superscript. For example, in document (6) the lexical item "clever" has a positive valence (+1). The corresponding attitude column contains an expression which relates an author (e.g., A), an attitude $\xrightarrow{n}$, and an entity (e.g., John). The author is by default the author of the document, but could be another as a document is not limited to a single author. The attitude symbol $\xrightarrow{n}$ expresses the author's attitude towards an entity as a positive or negative number n above the arrow. In one embodiment, n can be determined by summing the valence values of lexical items (referring to a particular entity/event) after they have been adjusted to reflect the influence of the contexts in which they occur. In another embodiment, n can be determined by a weighted average of lexical items (referring to a particular entity/event).

Referring to Table 3, document (6) has lexical item "clever" (in italic typeface for readability). In one embodiment, the base valence of "clever" can be +1, which is indicated by a superscript. The corresponding attitude expression reflects this as a positive attitude towards entity "John" (+1). Document (7) includes a negator "not" (in bold typeface for readability) indicating that it acts to negate the valence of lexical items in its scope. In this case, "not" negates the positive valence of "clever" resulting in a negative attitude expressed towards John (−1). Similar examples are provided in documents (8) and (9).

In one embodiment, CVS's can serve to attenuate or strengthen valence rather than negate it (e.g., "less" in "less efficient" or "deeply" in "deeply suspicious"). This type of CVS is referred to as an intensifier. Referring again to Table 3, documents (10)-(12) illustrate intensifiers. In one embodiment, intensifiers can reduce or increase the valence of lexical items in their scope. For example, in document (10) the lexical item "successful" which has a base valence of +1 has been neutralized by the intensifier "seldom". In document (11), the intensifier "always" has the effect of strengthening the positive value of "successful" (+2). In document 12, "less" weakens the valence of the "successful" (+0.5).

TABLE 4

Presupposition Examples

	DOCUMENT	ATTITUDE
(13)	It is *sufficient*$^{+1}$.	*A* $\xrightarrow{+1}$ *It*
(14)	It is **barely** *sufficient*$^{+1}$.	*A* $\xrightarrow{0}$ *It*
(15)	He *barely*$^{-1}$ got into Foothill College.	*A* $\xrightarrow{-1}$ *He*
(16)	He *even*$^{+1}$ got into Harvard.	*A* $\xrightarrow{+1}$ *He*
(17)	He **failed** to tell me she had been in *jail*$^{-1}$.	*A* $\xrightarrow{-1}$ *She* *A* $\xrightarrow{-1}$ *He*
(18)	The *brilliant*$^{+1}$ organizer **failed** *to solve the problem*$^{+1}$.	*A* $\xrightarrow{-1}$ *Organizer*

In one embodiment, a presupposition can alter the valency of lexical items in its scope. Expectations that are not borne-out can have positive and negative consequences in terms of the valence of a lexical item under consideration. A presupposition not only conveys information that something has (or has not) happened but also that the author was expecting otherwise. Referring to Table 4, document (13) illustrates lexical item "sufficient" in one embodiment has a base valence of +1. The presupposition introduced by the CVS "barely" in (14) modifies "sufficient" to suggest that the author believed that "it" should have been sufficient, but hardly was. Therefore, the valence ascribed to "sufficient" is neutralized, reflecting the author's negative attitude towards the entity/event represented by "it".

In one embodiment, CVS's that would introduce presuppositions can have a negative or a positive connotation even when there are no lexical items in their scope. Referring again to Table 4, the term "barely" in document (15) leads to the conclusion that it should have been much easier for the entity referred to by "he" to get into Foothill College. Since this was not the case, the document reflects the author's negative assessment of the entity as delineated in the corresponding attitude expression. Likewise, document (16) illustrates that the author did not expect the entity referred to by "he" to get into Harvard, but he nonetheless did. The result is reflected as a positive attitude towards the entity (+1).

Document (17) in Table 4 illustrates an attitude expression involving more than one entity. One entity is referred to by "he" and the other by "she". The author expresses a negative attitude towards the entity referred to by "she" through the use of the lexical item "jail" which has a base valence of −1. Indirectly, the author is also expressing a negative assessment of the entity referred to by "he" through the use of a presupposition introduced by the term "failed" since the author expected that "he" should have shared this information with the author but did not. Use of a term that carries a presupposition can also lead to irony, as is the case in document (18). Here, the lexical item "solve the problem" has a positive base valence (+1) as does "brilliant" (+1). However, the presence of the term "failed" serves to neutralize the valence of "solve the problem". But there is also an indirect negative evaluation of the person to whom the

failure is attributed. By ironically referring to the ineffective "organizer" as "brilliant", the author is also expressing a negative attitude towards the "organizer". Thus, the adjusted attitude is calculated by adding brilliant (−1) +solve the problem (0)=−1.

TABLE 5

Connector Examples

	DOCUMENT	ATTITUDE
(19)	**Although** Boris is *brilliant*$^{+1}$ at math, he is a *horrible*$^{-1}$ teacher.	*A* —-1→ *Boris*
(20)	Experts believe that at least half of all Americans will have the *freedom*$^{+1}$ *to chose*$^{+1}$ their electricity supplier within the next five years. **Yet** many Americans remain **deeply** *suspicious*$^{-1}$.	*A* —-1→ *View of Deregulation*

In one embodiment, connectors such as "although", "however", "but", "on the contrary", "notwithstanding", etc. not only introduce information, they specifically act on information elsewhere in the text to mitigate the force of that information and thus serve as CVS's. For example, in document (19) (Table 5) while the statement "Boris is brilliant at math" positively assesses Boris' math skills, the force of "although" combined with the negative assessment in the sentence's main clause "he is a horrible teacher" effectively neutralizes the positive force of the evaluation as applied to Boris. In computing the author's attitude towards Boris, therefore, the effect of the connector "although" is to neutralize the effect of the positive assessment, resulting in a negative assessment score for the sentence.

In one embodiment, connectors that function within sentences (e.g., "however") can also function across sentences. By way of a non-limiting example, consider the first sentence in document (20) (Table 5). The valence of all attitude expressing terms in the first sentence is positive: freedom (+1), to choose (+1). The initial valence computation is +2. The second sentence begins with the connector "yet" which, unlike "although", applies to mitigate the force of information which precedes it. In this example, "yet" followed by negative valenced terms acts to neutralize the force of the positive terms in the preceding paragraph. Thus, in computing the attitude of the author towards American views of deregulation, the initial valence computation of the first sentence is recomputed to 0 and the sum score for both sentences is −1.

TABLE 6

Modal Examples

	DOCUMENT	ATTITUDE
(21)	Mary is a *terrible*$^{-1}$ person. She is *mean*$^{-1}$ to her dogs.	*A* —-2→ *Mary*
(22)	**If** Mary were a *terrible*$^{-1}$ person, she would be *mean*$^{-1}$ to her dogs.	*A* —0→ *Mary*

Natural language makes a distinction between events or situations which are asserted to have happened, are happening or will happen (realis events) and those which might, could, should, ought to, or possibly occurred or will occur (irrealis events). For example, "if" is a term which creates an irrealis context. The CVS's which set up a context of possibility or necessity are called modal operators and in documents they initiate a context in which lexical items express an attitude towards entities which does not necessarily reflect the author's attitude towards those entities in an actual situation under discussion. While, as is the case with individual connectives discussed above, precisely how each modal operator functions to modify base valence may differ, in one embodiment each operator will function to shift the valence in some manner and to some degree.

Referring to Table 6 and document (21), the lexical items "terrible" and "mean" are negatively valenced. The combined score for score for the sentences is −2. However, the sentence in document (22) does not assert either that Mary is a terrible person or that she is mean to her dogs. On the contrary, the force of "were" suggests that she is not mean to her dogs while the "if" sets up a context in which Mary is not necessarily a terrible person. Therefore, the modal operators neutralize the base valence of "terrible" and "mean", resulting in a neutral attitude expression. Similarly to some connectives (e.g., "however") modal context initiators may set up irrealis contexts that span more than one sentence. In such so-called modal subordination cases, all of the valence terms within the scope of the irrealis term are modified even though they may occur in different sentences.

In one embodiment, there are three CVS's which operate at the linguistic level of a discourse and modify the base valence of terms within their scope: Reported Speech and Thought, Elaboration, and Genre.

TABLE 7

Reported Speech and Thought Examples

	DOCUMENT	ATTITUDE
(23)	Mary was a *slob*$^{-1}$.	*A* —-1→ *Mary*
(24)	John **said** that Mary was a *slob*$^{-1}$.	*John* —-1→ *Mary* *A* —0→ *Mary*
(25)	John **said** that Mary was a *slob*$^{-1}$ and he is *right*$^{+1}$.	*John* —-1→ *Mary* *A* —-1→ *Mary* *A* —+1→ *John*
(26)	The utilities **argue** that they performed *glowingly*$^{+1}$. *But* the public **remembers** those *gloomy*$^{-1}$, *rotten*$^{-1}$ nights.	*A* —-2→ *Utilities*

Table 7 contains examples illustrating Reported Speech and Thought CVS operators. In document (23), the attitude expression is −1 since "slob" has a base valence of −1. Document (24) introduces the reported speech operator

"said". What is being asserted by the author in document (24) is that John "said" something unflattering about Mary, not that the author accepts John's assessment of her. Since it would not be contradictory for a text to read: "John said that Mary was a slob but she is not," items within the scope of a Reported Speech or Thought operator in one embodiment are not initially be computed into the score evaluating an author's belief. Therefore, while John expresses a negative attitude towards Mary, this does not figure into the attitude of the document's author (which in this case remains neutral or zero). However, it is possible that information later in the document could force its inclusion. This is the case in document (25) wherein the author is asserting that John said something unflattering about Mary and that the author agrees with John's assessment. Therefore, the negative valence attached to "slob" will be counted along with the positive valence of "right".

In document (26), both "argue" and "remembers" are examples of Reported Speech and Thought operators. Therefore, the valence of the reported material is initially not ascribed to the author. However, the "but" which sets up the contrast between what was argued and what was remembered has been chosen by the author to contrast mere arguing with remembering which, while expressing a mental state, is also assumed to pertain to events that did happen. The net result is that the utilities argument is ignored while the public's memory is included. In one embodiment, Reported Speech and Thought contexts can be detected using standard natural language processing techniques.

TABLE 8

Elaboration Examples

	DOCUMENT	ATTITUDE
(27)	John walks a lot. Last month he walked 25 miles on Tuesdays. Wednesdays he walked another 25 miles. Every weekend he hikes at least 50 miles each day.	$A \xrightarrow{0} John$
(28)	John is a $terrific^{+1}$ athlete. Last week he walked 25 miles on Tuesdays. Wednesdays he walked another 25 miles. Every weekend he hikes at least 50 miles a day.	$A \xrightarrow{+4} John$
(29)	Through this year's $sweltering^{-1}$ summer, many homes from New York to New Orleans lost power (and with it, their $air\ conditioning^{+1}$). Downtown Chicago was $plunged^{-1}$ into $darkness^{-1}$ and the businesses were $silenced^{-1}$. A major university laboratory $even^{-1}$ lost decades of frozen samples.	$A \xrightarrow{-5} Utilities$
(30)	John is a $terrific^{+1}$ athlete. Last week he slept 5 hours on Tuesday during the day. Wednesdays he napped for another 5 hours. Every weekend he spends at least 15 hours a day resting up in his hammock.	$A \xrightarrow{-4} John$

The second discourse CVS is Elaboration. Elaboration concerns the discourse structure itself and how it affects the base valence of lexical items. In one embodiment, a discourse structure be represented by a structural analysis of a source text (e.g. document) which represents the source text in terms of semantic relationships between units of the text. This can be accomplished by segmenting the source text into discourse units (DU's). DU's are portions of text small enough for the particular structural analysis technique employed to extract semantic meaning from and thereby build a semantically correct structural representation of the source text. Automatic segmentation of the source text can be accomplished by statistical methods or by shallow or deep parsing techniques. Statistical methods of segmentation use machine learning techniques to tag words and then aggregate strings of tagged words into structures that learning algorithms expect to correspond to DU's. Shallow parsing methods use tagged words and knowledge of some simple linguistic structures to break sentences into clauses and phrases. Deep parsing methods use word tagging and extensive rules to produced detailed analysis of the relations obtaining among the words making up a sentence.

Once a source text is segmented, a structural representation (e.g., a discourse tree) can be created based on semantic relationships among DU's. In one embodiment of the invention, two such relations are lists and elaborations. A list relationship involves associating DU's that express a similar relationship to some more general concept. An elaboration relation involves DU's that give more detailed information of some sort about other DU's preceding them in the linear organization of the text. These earlier DU's structurally dominate the elaborating DU's. Both symbolic and statistical natural language processing methods can be applied to determining discourse structure for documents in limited domains.

Table 8 illustrates documents in which elaboration operates through the structure of discourse to modify the base valence of lexical items. Document (27) is an example of an elaboration in which lexical valence does not play a role. For purposes of non-limiting illustration, each sentence in documents (27)-(30) corresponds to a DU and elaborating DU's are indented. The first sentence is considered the dominating DU. The last three sentences of document (27) each give more detail about John's walking a lot: last month he walked 5 miles on Tuesdays; Wednesdays he walked another 25 miles; and every weekend he hikes at least 50 miles each day. These sentences illustrate the concept in the dominating DU. In document (28), lexical valence information is introduced in "terrific" in the dominating DU. Since each of the dominated DU's is an example of athleticism, the positive valence of terrific is inherited by each DU. This can be paraphrased by saying, John's terrific athleticism is attested to by the fact that: 1) last week he walked 5 miles on Tuesdays; 2) Wednesdays he walked another 5 miles; and 3) every weekend he hikes at least 15 miles a day. Effectively, the score for this one instance of the positively valenced term "terrific" as applied to the entity John is multiplied by four.

In document (29), the elaborating DU's contain at least one negatively valenced lexical item that illustrate losing power during a sweltering summer. The negative valence of the elaborating items is −4. This can then be combined with the dominating DU's valence of −1, yielding an attitude expression of −5. This might be offset by "air conditioning", a positively valenced term. However, the positive air conditioning was lost, which neutralizes the positive force of air conditioning.

A related process can be used to determine in some cases if a valenced lexical item is being used ironically. Consider document (30). In contrast to the previous example of John's athletic ability, the elaborating information contradicts the positively valenced assertion in the dominating sentence, thereby effectively negating it. However, the effect of such

an ironic use of language is stronger than merely neutralizing a positive or negative statement, rather the force of the rhetorical figure of irony can be computed as follows:

John is NOT a terrific athlete. Evidence for NOT:
Last week he slept 5 hours on Tuesday during the day.
Wednesdays he napped for another 5 hours
Every weekend he spends at least 15 hours a day resting up in his hammock.

Adjusted valence is −4.

TABLE 9

Genre Example

	DOCUMENT	ATTITUDE
(31)	This film **should** be *brilliant*$^{+1}$. The characters are *appealing*$^{+1}$. Stallone plays a *happy*$^{+1}$, *wonderful*$^{+1}$ man. His *sweet*$^{+1}$ wife is beautiful and adores him. He has a *fascinating*$^{+1}$ *gift*$^{+1}$ for living life to the fullest. It sounds like a *great*$^{+1}$ story, **however** it *can't hold up*$^{-1}$.	*A* $\xrightarrow{-2}$ *John*

Documents can display the hierarchical discourse structure discussed above. However, documents can also be created in conformity with document genre constraints. For example, an obituary in a newspaper reflects a set of organizing principles that dictate the order of information, the type of language used and the types of information considered appropriate. Similarly, an instructive manual, a product review, a persuasive article or a review of a movie will each display the form and stylistic conventions of the document genre to which it belongs. These document level genre constraints can be exploited in determining the attitude of authors towards the entities in the documents they create.

Table 9 contains an example of a movie review. A movie review can contain two types of information: information about the events and situations in the story and information about the film which has been created to tell the story. Information about the story can involve recounting the events in the story and talking about the characters played by the actors; information about the film can include descriptions and explicit evaluations of the acting, the directing, the script and other aspects of the production. In one embodiment, it is necessary to separate the description of the entities pertaining to the story from the description of the entities pertaining to the production. Only the valence scores of the entities pertaining to the production should be considered in ascertaining if the review is positive or negative.

Document (31) in Table 9 illustrates a common rhetorical strategy in reviews which is to present thwarted expectations: where the author sets up a deliberate contrast to an expected position. In the first sentence, "brilliant" is within the scope of presupposition "should" and is neutralized. In the second sentence, "appealing" is an elaboration under "should"—its effect is also neutralized. "Happy", "wonderful", "sweet", etc. all refer to story world entities and thus do not count. In the last sentence, the valence of "great" is reversed by the connector "however". Thus, the adjusted score for the document is −2.

In another embodiment, prosody and intonation can be used to adjust the valence of spoken lexical items. This approach is disclosed in SYSTEMS AND METHODS FOR DYNAMICALLY DETERMINING THE ATTITUDE OF A NATURAL LANGUAGE SPEAKER, U.S. application Ser. No. 10/387,719, Inventors: Livia Polanyi, et al., filed on Mar. 13, 2003, which is hereby incorporated by reference in its entirety.

FIG. **1** is a flow chart illustrating one embodiment of the invention. FIG. **1** depicts general method steps for illustrative purposes and in no way should be interpreted as limiting any embodiment to particular steps or a particular arrangement of steps. In addition, not all steps need be applied. Natural language document **100** is provided to step **102**. Step **102** identifies entities/events in the document using any information extraction techniques currently in use or to be developed in the future. Depending on the granularity of the information extraction, fewer or greater numbers of entities will be identified. In one embodiment, step **102** maintains associations betweens identified entities and the lexical items that refer to them for use in step **114**. Next, step **104** determines the base valence of lexical items in the document. In one embodiment, step **104** utilizes a lexical resource. In another embodiment, domain information is derived from the document to aid in determining the appropriate base valence. In yet another embodiment, step **104** can associate authors with lexical items as it determines base valence. Step **106** adjusts the base valence of the lexical items by taking into account the affect of CVS's in steps **108**-**112**.

In Step **108**, the affect of negators, intensifiers, presuppositions, connectors and modals can be determined. Negators can negate valence. Intensifiers can strengthen or weaken valence. Presuppositions can have a negative impact on valence if the consequences of a not born-out expectation are negative and can have a positive impact if the consequences are positive. Connectors indicate a different point of view and can neutralize or negate valence. Modals establish a condition wherein the condition can neutralize or negate the valence. In step **110**, the affect of reported speech/thought, elaboration and genre constraints can be computed. Reported speech/thought describes a context in which attitude is ascribed to a document entity rather than a document author and can neutralize valence. Elaborations adjusts valence to reflect the valence of at least one elaborating lexical item that elaborates on a lexical item under consideration. Genre adjusts valence using knowledge of expected genre content (e.g., a movie review). If the natural language document contains spoken language, adjustments to the base valence based on prosody and intonation can be determined in step **112**.

Finally, step **114** associates attitudes expressed by the adjusted valences determined in step **106** with their authors and target entities/events. In one embodiment, an author's attitude towards an entity/event can be expressed as the summation of all adjusted valences of lexical items attributable to the author that refer to the entity/event. This can be provided to output **116** as a set associations wherein each association comprises an author, an attitude and an entity/event.

FIG. **2** is diagram of a system in accordance to one embodiment of the invention. Although this diagram depicts objects as functionally separate, such depiction is merely for illustrative purposes. It will be apparent to those skilled in the art that the objects portrayed in FIG. **2** can be arbitrarily combined or divided into separate software, firmware or hardware components. Furthermore, it will also be apparent to those skilled in the art that such objects, regardless of how they are combined or divided, can execute on the same computing device or can be arbitrarily distributed among different computing devices connected by a network.

Natural language document **200** is provided to entity identification module **202** and base valence calculator **204**. Base valence calculator **204** determines the base valence for each lexical item in document **200**. In one embodiment, base valence calculator **206** utilizes a lexical resource and domain information to determine the base valence of a lexical item. Contextual valence adjuster **210** is coupled to base valence calculator **204** and adjusts the base valence of lexical items based one or more CVS's. In one embodiment, module **210** associates attitudes expressed by the adjusted valences determined in step **106** with their authors and provides this information to attitude mapper **212**. Entity identifier **202** identifies entities in document **200** and provides this information to attitude mapper **212**. Attitude mapper **212** associates the entities provided by module **202** with the author/attitude pairs provided by module **210** to generate a set of attitude relations **214** that comprise an association/between an author, an attitude and an entity/event.

One embodiment may be implemented using a conventional general purpose or a specialized digital computer or microprocessor(s) programmed according to the teachings of the present disclosure, as will be apparent to those skilled in the computer art. Appropriate software coding can readily be prepared by skilled programmers based on the teachings of the present disclosure, as will be apparent to those skilled in the software art. The invention may also be implemented by the preparation of integrated circuits or by interconnecting an appropriate network of conventional component circuits, as will be readily apparent to those skilled in the art.

One embodiment includes a computer program product which is a storage medium (media) having instructions stored thereon/in which can be used to program a computer to perform any of the features presented herein. The storage medium can include, but is not limited to, any type of disk including floppy disks, optical discs, DVD, CD-ROMs, microdrive, and magneto-optical disks, ROMs, RAMs, EPROMs, EEPROMs, DRAMs, VRAMs, flash memory devices, magnetic or optical cards, nanosystems (including molecular memory ICs), or any type of media or device suitable for storing instructions and/or data.

Stored on any one of the computer readable medium (media), the present invention includes software for controlling both the hardware of the general purpose/specialized computer or microprocessor, and for enabling the computer or microprocessor to interact with a human user or other mechanism utilizing the results of the present invention. Such software may include, but is not limited to, device drivers, operating systems, execution environments/containers, and user applications.

The foregoing description of the preferred embodiments of the present invention has been provided for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise forms disclosed. Many modifications and variations will be apparent to the practitioner skilled in the art. Embodiments were chosen and described in order to best describe the principles of the invention and its practical application, thereby enabling others skilled in the art to understand the invention, the various embodiments and with various modifications that are suited to the particular use contemplated. It is intended that the scope of the invention be defined by the following claims and their equivalents.

What is claimed is:

1. A method for adaptively analyzing a natural language document containing at least one lexical item, said analysis to determine an attitude of an author towards an entity, comprising:

determining at least one actual valence for the at least one lexical item by analyzing the at least one lexical item in context;

determining the attitude based on the at least one actual valence;

associating the author, the entity and the attitude;

wherein the at least one lexical item encodes attitude information about the entity;

determining at least one base valence for the at least one lexical item; and

wherein analyzing the at least one lexical item includes adjusting the at least one base valence based on a contextual valence shifter (CVS) which can have a negative impact on the at least one base valence if the consequences of a not born-out expectation are negative and can have a positive impact on the at least one base valence if the consequences of the not born-out expectation are positive.

2. The method of claim **1** further comprising determining:

at least one additional CVS, where the additional CVS is different from the CVS identified in claim **1**, where the additional CVS is one of: a negator, an intensifier, a connector, a modal, reported speech/thought, an elaboration, and a genre.

3. The method of claim **2** wherein:

the additional negator CVS is a word or phrase that can negate the at least one base valence.

4. The method of claim **2** wherein:

The additional intensifier CVS is a word or phrase used for emphasis or de-emphasis that can strengthen or weaken the at least one base valence, respectively.

5. The method of claim **2** wherein:

the additional connector CVS is a word or phrase that indicates a different point of view and can neutralize or negate the at least one base valence.

6. The method of claim **2** wherein:

the additional modal CVS is a word or phrase that establishes a condition wherein the condition can neutralize or negate the at least one base valence.

7. The method of claim **2** wherein:

the additional reported speech/thought or other linguistic device CVS describes a context in which attitude is ascribed to a second entity rather than the author and can neutralize the at least one base valence with respect to the author.

8. The method of claim **7** wherein:

the additional reported speech/thought CVS does not neutralize the at least one base valence if the author adopts the attitude ascribed to the document entity.

9. The method of claim **2** wherein:

the additional elaboration CVS adjusts the at least one base valence to reflect the valence of at least one elaborating lexical item that elaborates on the lexical item.

10. The method of claim **9** wherein:

a contradiction between the lexical item and the at least one elaborating lexical item can indicate irony.

11. The method of claim **2** wherein:

the additional genre CVS adjusts the base valence using knowledge of expected genre content.

12. The method of claim **11** wherein:

the genre is a movie review.

13. The method of claim **1** wherein:

the at least one base valence represents positive or negative attitudinal information encoded in the lexical item.

14. The method of claim 1 wherein:
determining the at least one base valence is based on taking into account the domain in which the at least one lexical item occurs.
15. The method of claim 1 wherein:
the at least one lexical item can be a contextual valence shifter.
16. A method for adaptively analyzing a natural language document containing at least one lexical item, said analysis to determine an attitude of an author towards an entity, comprising:
determining at least one base valence for the at least one lexical item,
determining at least one actual valence for the at least one lexical item by adjusting the at least one base valence based on at least one contextual valence shifter (CVS) which can have a negative impact on the base valence if the consequences of a not born-out expectation are negative and can have a positive impact on the base valence if the consequences of the not born-out expectation are positive;
determining the attitude based on the at least one actual valence;
associating the author, the entity and the attitude; and
wherein the at least one lexical item encodes attitude information about the entity.
17. The method of claim 16 further comprising determining:
at least one additional CVS, where the additional CVS is different from the CVS identified in claim 16, where the additional CVS is one of: a negator, an intensifier, a presupposition, a connector, a modal, reported speech/thought, an elaboration, and a genre.
18. The method of claim 17 wherein:
the additional negator CVS is a word or phrase that can negate the at least one base valence.
19. The method of claim 17 wherein:
the additional intensifier CVS is a word or phrase used for emphasis or de-emphasis that can strengthen or weaken the at least one base valence, respectively.
20. The method of claim 17 wherein:
the additional connector CVS is a word or phrase that indicates a different point of view and can neutralize or negate the at least one base valence.
21. The method of claim 17 wherein:
the additional modal CVS is a word or phrase that establishes a condition wherein the condition can neutralize or negate the at least one base valence.
22. The method of claim 17 wherein:
the additional reported speech/thought or other linguistic device CVS describes a context in which attitude is ascribed to a second entity rather than the author and can neutralize the at least one base valence with respect to the author.
23. The method of claim 22 wherein:
the additional reported speech/thought CVS does not neutralize the at least one base valence if the author adopts the attitude ascribed to the document entity.
24. The method of claim 17 wherein:
the additional elaboration CVS adjusts the at least one base valence to reflect the valence of at least one elaborating lexical item that elaborates on the lexical item.
25. The method of claim 24 wherein:
a contradiction between the lexical item and the at least one elaborating lexical item can indicate irony.
26. The method of claim 17 wherein:
the additional genre CVS adjusts the base valence using knowledge of expected genre content.
27. The method of claim 26 wherein:
the genre is a movie review.
28. The method of claim 16 wherein:
the at least one base valence represents positive or negative attitudinal information encoded in the lexical item.
29. The method of claim 16 wherein:
determining the at least one base valence is based on taking into account the domain in which the lexical item occurs.
30. The method of claim 16 wherein:
the at least one lexical item can be a contextual valence shifter.
31. A system for adaptively analyzing a natural language document containing at least one lexical item, said analysis to determine an attitude of an author towards an entity, comprising:
a base valence calculator to determine at least one base valence of the at least one lexical item;
a contextual valence adjuster coupled to the base valence calculator, the contextual valence adjuster to adjust the at least one base valence based on at least one contextual valence shifter (CVS) which can have a negative impact on the base valence if the consequences of a not born-out expectation are negative and can have a positive impact on the base valence if the consequences of the not born-out expectation are positive;
an entity identifier to identity the entity;
an attitude mapper coupled to the entity identifier and the contextual valence adjuster, the attitude mapper to determine the attitude based on the at least one adjusted valence and to associate the author, the entity, and an attitude.
32. The system of claim 31 wherein:
the base valence calculator utilizes a lexical resource; and
wherein the lexical resource provides the at least one base valence of the at least one lexical item.
33. The system of claim 32 wherein:
the lexical resource uses domain information to determine the at least one base valence.
34. The system of claim 31 wherein:
the base valence calculator utilizes domain information to determine a domain for the at least one lexical item.
35. The system of claim 31 further comprising determining:
at least one additional CVS, where the additional CVS is different from the CVS identified in claim 31, where the additional CVS is one of: a negator, an intensifier, a connector, a modal, reported speech/thought, an elaboration, and a genre.
36. The system of claim 35 wherein:
the additional negator CVS is a word or phrase that can negate the at least one base valence.
37. The system of claim 35 wherein:
the additional intensifier CVS is a word or phrase used for emphasis or de-emphasis that can strengthen or weaken the at least one base valence, respectively.
38. The system of claim 35 wherein:
the additional connector CVS is a word or phrase that indicates a different point of view and can neutralize or negate the at least one base valence.
39. The system of claim 35 wherein:
the additional modal CVS is a word or phrase that establishes a condition wherein the condition can neutralize or negate the at least one base valence.

40. The system of claim 35 wherein:
the additional reported speech/thought or other linguistic device CVS describes a context in which attitude is ascribed to a second entity rather than the author and can neutralize the at least one base valence with respect to the author.
41. The system of claim 40 wherein:
the additional reported speech/thought CVS does not neutralize the at least one base valence if the author adopts the attitude ascribed to the document entity.
42. The system of claim 35 wherein:
the additional elaboration CVS adjusts the at least one base valence to reflect the valence of at least one elaborating lexical item that elaborates on the lexical item.
43. The system of claim 42 wherein:
a contradiction between the lexical item and the at least one elaborating lexical item can indicate irony.
44. The system of claim 35 wherein:
the additional genre CVS adjusts the base valence using knowledge of expected genre content.
45. The system of claim 44 wherein:
the genre is a movie review.
46. The system of claim 31 wherein:
the at least one base valence represents positive or negative attitudinal information encoded in the lexical item.
47. The system of claim 31 wherein:
the at least one lexical item can be a contextual valence shifter.
48. A machine readable medium having instructions stored thereon that when executed by a processor cause a system to:
determine at least one actual valence for the at least one lexical item by analyzing the at least one lexical item in context;
determine the attitude based on the at least one actual valence;
associate the author, the entity and the attitude;
wherein the at least one lexical item encodes attitude information about the entity determining at least one base valence for the at least one lexical item; and
wherein analyzing the at least one lexical item includes adjusting the at least one base valence based on a contextual valence shifter (CVS) which can have a negative impact on the base valence if the consequences of a not born-out expectation are negative and can have a positive impact on the base valence if the consequences of the not born-out expectation are positive.
49. The machine readable medium of claim 48 further comprising instructions for determining:
at least one additional CVS, where the additional CVS is different from the CVS identified in claim 48, where the additional CVS is one of: a negator, an intensifier, a connector, a modal, reported speech/thought, an elaboration, and a genre.
50. The machine readable medium of claim 49 wherein:
the additional negator CVS is a word or phrase that can negate the at least one base valence.
51. The machine readable medium of claim 49 wherein:
the additional intensifier CVS is a word or phrase used for emphasis or de-emphasis that can strengthen or weaken the at least one base valence, respectively.
52. The machine readable medium of claim 49 wherein:
the additional connector CVS is a word or phrase that indicates a different point of view and can neutralize or negate the at least one base valence.
53. The machine readable medium of claim 49 wherein:
the additional modal CVS is a word or phrase that establishes a condition wherein the condition can neutralize or negate the at least one base valence.
54. The machine readable medium of claim 49 wherein:
the additional reported speech/thought or other linguistic device CVS describes a context in which attitude is ascribed to a second entity rather than the author and can neutralize the at least one base valence with respect to the author.
55. The machine readable medium of claim 54 wherein:
the additional reported speech/thought CVS does not neutralize the at least one base valence if the author adopts the attitude ascribed to the document entity.
56. The machine readable medium of claim 49 wherein:
the additional elaboration CVS adjusts the at least one base valence to reflect the valence of at least one elaborating lexical item that elaborates on the lexical item.
57. The machine readable medium of claim 56 wherein:
a contradiction between the lexical item and the at least one elaborating lexical item can indicate irony.
58. The machine readable medium of claim 49 wherein:
the additional genre CVS can adjust the base valence using knowledge of expected genre content.
59. The machine readable medium of claim 58 wherein:
the genre can be a movie review.
60. The machine readable medium of claim 48 wherein:
the at least one base valence represents positive or negative attitudinal information encoded in the lexical item.
61. The machine readable medium of claim 48 wherein:
determining the at least one base valence is based on taking into account the domain in which the at least one lexical item occurs.
62. The machine readable medium of claim 48 wherein:
the at least one lexical item can be a contextual valence shifter.

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